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TITLE: TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL (TCP/IP) PACKET-CENTRIC WIRELESS POINT TO MULTI-POINT (PTMP) TRANSMISSION SYSTEM ARCHITECTURE

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Abstract Paragraph - ABTX (1):

A packet-centric wireless point to multi-point telecommunications system includes: a wireless base station communicating via a packet-centric protocol to a first data network; one or more host workstations communicating via the packet-centric protocol to the first data network; one or more subscriber customer premise equipment (CPE) stations coupled with the wireless base station over a shared bandwidth via the packet-centric protocol over a wireless medium; and one or more subscriber workstations coupled via the packet-centric protocol to each of the subscriber CPE stations over a second network. The packet-centric protocol can be transmission control protocol/internet protocol (TCP/IP). The packet-centric protocol can be a user datagram protocol/internet protocol (UDP/IP). The system can include a **resource** allocation means for allocating shared bandwidth among the subscriber CPE stations. The **resource** allocation is performed to **optimize** end-user quality of service (QoS). The wireless communication medium can include at least one of: a radio frequency (RF) communications medium; a cable communications medium; and a satellite communications medium. The wireless communication medium can further include a telecommunications access method including at least one of: a time division multiple access (TDMA) access method; a time division multiple access/time division duplex (TDMA/TDD) access method; a code division multiple access (CDMA) access method; and a frequency division multiple access (FDMA) access method.

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Summary of Invention Paragraph - BSTX (12):

[0009] The system can include a **resource** allocation means for allocating shared bandwidth among the subscriber CPE stations. The **resource** allocation is performed to **optimize** end-user quality of service (QoS). The wireless communication medium can include at least one of: a radio frequency (RF) communications medium; a cable communications medium; and a satellite communications medium. The wireless communication medium can further include a telecommunications access method including at least one of: a time division multiple access (TDMA) access method; a time division multiple access/time division duplex (TDMA/TDD) access method; a code division multiple access (CDMA) access method; and a frequency division multiple access (FDMA) access method.

Summary of Invention Paragraph - BSTX (14):

[0011] The system of claim 1 can include a **resource** allocator that allocates shared bandwidth among the subscriber CPE stations. The **resource** allocator **optimizes** end-user quality of service (QoS). The **resource** allocator can be application aware as well.

Brief Description of Drawings Paragraph - DRTX (20):

[0031] FIG. 9 illustrates how a downlink flow scheduler can take into account a **service level agreement** in prioritizing a frame slot and scheduling **resource** allocation;

Detail Description Paragraph - DETX (12):

[0066] The concept of quality of service (QoS) is one of the most difficult and least understood topics in data networking. Although a common term in data networking, there are many different usages and definitions for QoS, leading to confusion regarding an exact meaning in precise or quantitative terms. Even further confusion is found when attempts are made to **measure** or specify numeric quantities sufficient to allow comparison of equipment or network performance with respect to QoS.

Detail Description Paragraph - DETX (18):

[0072] QoS can be a relative term, finding different meanings for different users. A casual user doing occasional web browsing, but no file transfer protocol (FTP) file downloads or real time multimedia sessions may have different a different definition of QoS than a power user doing many FTP file downloads of large **database** or financial files, frequent H.323 video conferencing and IP telephony calls. Also, a user can pay a premium rate (i.e. a so-called **service level agreement (SLA)**) for high network availability, low latency, and low jitter, while another user can pay a low rate for occasional web surfing only, and on weekends only. Therefore, perhaps it is best to understand QoS as a continuum, defined by what network performance characteristic is most important to a particular user and the user's **SLA**. Maximizing the end-user experience is an essential component of providing wireless QoS.

Detail Description Paragraph - DETX (22):

[0076] QoS can be thought of as a mechanism to selectively allocate scarce networking, transmission and communications **resources** to differentiated classes of network traffic with appropriate levels of priority. Ideally, the nature of the data traffic, the demands of the users, the conditions of the network, and the characteristics of the traffic sources and destinations all modify how the QoS mechanism is operating at any given instant. Ultimately, however, it is desirable that the QoS mechanism operate in a manner that provides the user with optimal service, in whatever manner the user defines it.

Detail Description Paragraph - DETX (30):

[0084] Simply providing "adequate" bandwidth is not a sufficient QoS

mechanism for packet-switched networks, and certainly not for wireless broadband access systems. Although some IP-flows are "bandwidth-sensitive," other flows are latency- and/or jitter-sensitive. Real time or multimedia flows and applications cannot be guaranteed timely behavior by simply providing excessive bandwidth, even if it were not cost-prohibitive to do so. It is desirable that QoS mechanisms for an IP-centric wireless broadband access system recognize the detailed flow-by-flow requirements of the traffic, and allocate system and media **resources** necessary to deliver these flows in an optimal manner.

Detail Description Paragraph - DETX (32):
[0086] Ultimately, the end-user experience is the final arbiter of QoS. It is desirable that an IP-centric wireless broadband access system assign and regulate system and media **resources** in a manner that can maximize the end-user experience. For some applications such as an initial screen of a Web page download, data transmission speed is the best **measure** of QoS. For other applications, such as the download or upload of a spreadsheet, the best **measure** of QoS can be the minimization of transmission error. For some applications, the best **measure** of QoS can be the optimization of both speed and error. For some applications, the timely delivery of packets can be the best **measure** of QoS. It is important to note that fast data transmission may not be the same as timely delivery of packets. For instance, data packets that are already "too old" can be transmitted rapidly, but by being too old can be of no use to the user. The nature of the data application itself and the desired end-user experience then can provide the most reliable criteria for the QoS mechanism. It is desired that an IP-centric wireless broadband access system provide a QoS mechanism that can dynamically **optimize** system behavior to each particular IP flow, and can also adapt to changes with changing network load, congestion and error rates.

Detail Description Paragraph - DETX (33):
[0087] 4. **Service Guarantees and Service Level Agreements (SLAs)**

Detail Description Paragraph - DETX (34):
[0088] Service guarantees can be made and **service level agreements (SLAs)** can be entered into between a telecommunications service provider and a subscriber whereby a specified level of network availability can be described, and access charges can be based upon the specified level. Unfortunately, it is difficult to quantify the degree of network availability at any given time, and therefore this becomes a rather crude **measure** of service performance. It is desired that data delivery rate, error rate, retransmissions, latency, and jitter be used as **measures** of network availability, but **measuring** these quantities on a real-time basis can be beyond the capability of conventional network service providers (NSPs).

Detail Description Paragraph - DETX (35):
[0089] Another level of service discrimination desired by network **service providers is a service level agreement (SLA)** that provides for differing traffic rates, network availability, bandwidth, error rate, latency and jitter

guarantees. It is desired that an IP-centric wireless broadband access system be provided that can provide for **SLAs,** enabling service providers to have more opportunities for service differentiation and profitability.

Detail Description Paragraph - DETX (37):
[0091] In order to implement a practical QoS mechanism, it is desired that a system be able to differentiate between types of traffic or service types so that differing levels of system **resources** can be allocated to these types. It is customary to speak of "classes of service" as a means of grouping traffic types that can receive similar treatment or allocation of system and media **resources**.

Detail Description Paragraph - DETX (53):
[0107] Unfortunately, if there is downlink data channel congestion, or congestion caused by an overabundance of high priority traffic, the condition of "buffer starvation" can occur. Because of the relative volume of high priority packets consuming a majority of buffer space, little room is left for lower priority packets. These lower priority packets can experience significant delays while system **resources** are devoted to the high priority packets. In addition to low priority packets being held in buffers for long periods of time, or never reaching the buffers, resulting in significantly delayed data flows for these packets, the actual applications corresponding to these low priority packets can also be disrupted, and stop working. Because of the nature of this queuing approach, overall latency and jitter and RTT for lower priority packets can be unpredictable, having an adverse effect on QoS.

Detail Description Paragraph - DETX (56):
[0110] By allocating queue space and system **resources** to packets based on the class of the packets, buffer starvation can be avoided. Each class can be defined to include of data flows with certain similar priorities and types. All classes can be given a certain minimum level of service so that one high priority data flow cannot monopolize all system **resources**. With the classification approach, because no data flow is ever completely shut off, the source application can receive information about the traffic rate, and can be able to provide TCP-mediated transmission rate adjustment supporting smooth traffic flow.

Detail Description Paragraph - DETX (59):
[0113] A weighted fair queuing method can attempt to provide low-volume flows with guaranteed queuing **resources,** and can then allow remaining flows, regardless of volume or priority, to have equal amounts of **resource**. Although this can prevent buffer starvation, and can lead to somewhat better latency and jitter performance, it can be difficult to attain stable performance in the face of rapidly changing RF downlink channel bandwidth availability.

Detail Description Paragraph - DETX (63):
[0117] The TCP/IP protocol stack has become the standard method of transmitting data over the Internet, and increasingly it is becoming a standard

in virtual private networks (VPNs). The TCP/IP protocol stack includes not only internet protocol (IP), but also transmission control protocol (TCP), user datagram protocol (UDP), and internet control message protocol (ICMP). By assuming that the TCP/IP protocol stack is the standard network protocol for data communications, the creation of a set of optimal QoS mechanisms for the wireless broadband data environment is more manageable. QoS mechanisms can be created that can span the entire extent of the network, including both the wireline and the wireless portions of the network. These mechanisms can integrate in a smooth and transparent manner with TCP rate control mechanisms and provide end-to-end QoS mechanisms that are adaptive to both the wireline and wireless portions of the network. Of course, segments of the wireline network that are congested or are experiencing other transport problems cannot be solved by a wireless QoS mechanism. However, a wireless QoS mechanism can **optimize** data flows in a manner that can enhance the end user experience when there is no severe wireline network congestion or bottleneck present.

Detail Description Paragraph - DETX (72):
[0126] These definitions could add significantly to networks, routers and access devices in differentiating different types of flow so that **resources** could be appropriately allocated, resulting in improved QoS. However, the proposal has not been widely used. Several proposals in the IETF could make use of this field, along with **resource** reservation protocol (RSVP), to improve network handling of packets.

Detail Description Paragraph - DETX (78):
[0132] If multiple users share a wireless radio link as with the present invention, the inherently high BER of the medium could potentially cause frequent packet loss leading to unproductive TCP retransmission in congestion avoidance mode. Because wireless bandwidth can be a precious commodity, a IP-centric wireless QoS mechanism preferably provides for packet retransmission without invoking TCP retransmission and consequent and unnecessary "whipsawing" of the transmission rate. This, along with several other factors, makes desirable creation of an IP-centric wireless media access control (MAC) layer. One function of an IP-centric MAC layer can be to mediate local retransmission of lost packets without signaling TCP and unnecessarily altering the TCP transmission speed. A primary task of the IP-centric wireless MAC layer is to provide for shared access to the wireless medium in an orderly and efficient manner. The MAC layer according to the present invention, Proactive Reservation-based Intelligent Multimedia-aware Media Access (PRIMMA) layer, available from Malibu Networks Inc., of Calabasas, Calif., can also schedule all packet transmissions across the wireless medium on the basis of, e.g., IP flow type, **service level agreements (SLAs)**, and QoS considerations.

Detail Description Paragraph - DETX (83):
[0137] In the wireline world, random early detection (RED) can be used to circumvent global synchronization. By randomly selecting packets from randomly selected packet flows before congestion collapse occurs, global synchronization can be avoided. Queues can be **monitored,** and when queue depth exceeds a preset limit, RED can be activated, activating asynchronously the TCP senders' transmission rate controllers. This can avoid the initial congestion which

would otherwise result in collapse and then global synchronization.

Detail Description Paragraph - DETX (89):
[0143] The implications for IP-centric wireless system architecture and design range from queue buffer capacity to local congestion avoidance strategies. Because wireless systems have the added burden of a high inherent BER, the effect of network-wide congestion behavior on local (wireless media channel) congestion avoidance strategies must be properly gauged and countered. For this reason, it is desirable that congestion avoidance algorithms of the IP-centric wireless system be crafted to **optimize** traffic flow with new mathematical and engineering considerations that until very recently were not apparent or available to system designers.

Detail Description Paragraph - DETX (99):
[0153] Based on a specific set of QoS requirements of each IP application flow in the IP-centric wireless system, applications are switched in a "proactive" manner by appropriate reservations of bandwidth over the wireless medium. The wireless transmission frames in each direction are constructed in a manner dictated by the individual QoS requirements of each IP flow. By using QoS requirements to build the wireless transmission frames, optimal QoS performance can result over the entire range of applications being handled by the system. For example, latency and jitter sensitive IP telephony, other H.323 compliant IP streams, and real-time audio and video streams can be given a higher priority for optimal placement in the wireless transmission frames. On the other hand, hypertext transport protocol (HTTP) traffic, such as, e.g., initial web page transmissions, can be given higher bandwidth reservation priorities for that particular application task. Other traffic without latency, jitter, or bandwidth requirements such as, e.g., file transfer protocol (FTP) file downloads, email transmissions, can be assigned a lower priority for system **resources** and placement in the wireless transmission frame.

Detail Description Paragraph - DETX (101):
[0155] Wireless end users are separated from a high speed, low BER wireline backbone by a lower speed, high BER wireless segment which can be subject to burst error events. TCP/IP traffic that traverses the wireless segment can experience frequent packet loss that, without intervention, can create congestion collapse and global synchronization as previously discussed. Therefore, it is desirable that the present invention's IP-centric wireless system make use of a TCP transmission rate agent that can **monitor** packet loss over the wireless segment, and can manage the remote TCP transmission rate function by recreating and transmitting any lost packet acknowledgments. The PRIMMA MAC layer can itself retransmit any lost packets over the wireless medium.

Detail Description Paragraph - DETX (138):
[0192] The STPs act as routers in the SS7 network, typically being provided as adjuncts to in-place switches. The STPs route messages from originating SSPs to destination SSPs. Architecturally, STPs can and are typically provided in "mated pairs" to provide redundancy in the event of congestion or failure

and to share **resources** (i.e., load sharing is done automatically). As illustrated in FIG. 2B, STPs can be arranged in hierarchical levels, to provide hierarchical routing of signaling messages. For example, mated STPs 222, 224 and mated STPs 226, 228 are at a first hierarchical level, while mated STPs 230, 232 are at a second hierarchical level.

Detail Description Paragraph - DETX (139):
[0193] SCPs provide **database** functions. SCPs can be used to provide advanced features in an SS7 network, including routing of special service numbers (e.g., 800 and 900 numbers), storing information regarding subscriber services, providing calling card validation and fraud protection, and offering advanced intelligent network (AIN) services. SCP 234 is connected to mated STPs 230 and 232.

Detail Description Paragraph - DETX (175):
[0229] FIG. 1C illustrates a conventional video network 150 such as, e.g., a cable television (CATV) network. Video network 150 can include video network 160 coupled to various video capture, distribution links and video output **monitors**. Video input devices can include, e.g., conference cameras 154 and 158. Video output devices can include, e.g., televisions 152 and 156. Video network 160 can include a variety of head end (i.e. the serving end of the cable) and distribution link equipment such as, e.g., coaxial cable television (CATV) and national television standard code (NTSC) tuner equipment for multiplexing various video signals.Standard cable systems have an immense amount of bandwidth available to them.

Detail Description Paragraph - DETX (240):
[0294] The Multipoint Control Unit (MCU) supports conferences between three or more endpoints. Under H.323, an MCU consists of a Multipoint Controller (MC), which is required, and zero or more Multipoint Processors (MP). The MC handles H.245 negotiations between all terminals to determine common capabilities for audio and video processing. The MC also controls conference **resources** by determining which, if any, of the audio and video streams will be multicast.

Detail Description Paragraph - DETX (242):
[0296] The present invention supports multicast for wireless base station 320, including providing: compatibility with RFC 1112, 1584; recognition and support of multicasting applications, including: multimedia, teleconferencing, **database**, distributed computing, real-time workgroups; support of broadcasting function over wireless link; preserves bandwidth, retains QoS latency performance; support of IPv6 IGMP and IPv4 IGMP multicast; group membership query, group membership **report** messages.

Detail Description Paragraph - DETX (246):
[0300] FIG. 2D depicts network 296 including a point-to-multipoint (PtMP) wireless network 298 coupled via router 140d to data network 142. It is important to note that network 296 includes network 286 from FIG. 2C, plus PtMP

wireless network 298. PtMP wireless network 298 enables customer premise equipment (CPE) at a subscriber location to gain access to the various voice, data and video **resources** coupled to data network 142 by means of wireless connectivity over a shared bandwidth. The wireless PtMP network 298 is a packet switched network which is TCP/IP packet-centric (i.e. no dedicated circuit is created in delivering a communication IP flow) and QoS aware.

Detail Description Paragraph - DETX (252):

[0306] Referring to FIG. 3B, one embodiment of the invention, antennae 292d and 292e are coupled to subscriber customer premise equipment (CPE) stations 294d and 294e, respectively (also referred to as CPEs 294d, 294e). Subscriber CPE stations 294d and 294e are coupled to various other CPE equipment via wireline or wireless connections. For example, CPE stations 290d and 290e can be coupled to voice calling parties 124d, 124e, 126d and 126e, fax machines 116d and 116e, video conferencing equipment including video **monitors** 152d and 152e, and cameras 154d and 154e, host computers including client computers 120d and 120e and servers 122d and 122e. Various legacy devices such as PBXs can be coupled to CPEs 294d and 294e. In addition, next generation technologies such as Ethernet phones available from Selsius, a subsidiary of CISCO Systems from San Jose, Calif. and other Internet appliances can be coupled via LAN connections to CPEs 294d and 294e. Other video conferencing equipment as well as H.323 compliant conferencing equipment can also be coupled to CPEs 294d and 294e.

Detail Description Paragraph - DETX (256):

[0310] Returning to FIG. 3B, it depicts block diagram 310 further illustrating the wireless PtMP of the present invention. Diagram 310 includes wireless base station 302 coupled at interface 320 to data network 142. Also coupled to data network 142 are router 140d and telephony gateway 288b which is in turn coupled to a class 5 central office (CO) switch at EO 104b. IP telephony gateway 288b can terminate telephony traffic to PSTN facilities by, e.g., translating packets into time domain multiplexed (TDM) standard telephone signals. Wireless base station 302 is in communication with wireless CPE 294d at subscriber location 306d via antenna WAP 290d and 292d. It would be apparent to those skilled in the art that other configurations of CPE 294d are possible, such as, e.g., one or more host computers with no telephone devices, one or more telephones with no host computers, one or more host computers and one or more telephone devices, and one or more H.323 capable video-conferencing platforms which could include a host computer with **monitor** and camera.

Detail Description Paragraph - DETX (261):

[0315] In an example embodiment, physical layer 402 can be implemented using several wireless application specific integrated circuits (wASICs), an off-the-shelf 16QAM/QPSK 416 ASIC; an Interference Mitigation and Multipath Negation (IMMUNE)/RF 418 algorithm ASIC for minimizing and/or eliminating harmful interference; and a frequency hopping (FH) 419 ASIC for providing dynamic and adaptive multi-channel transmission that **optimizes** data link integrity by changing frequency levels depending on the noise level of a given frequency. Physical layer 402 can include the radio frequency (RF) signal 415.

Detail Description Paragraph - DETX (269):
[0323] 3. **Resource** Reservation Protocol (RSVP)

Detail Description Paragraph - DETX (271):
[0325] **Resource** reservation protocols that operate on a per-connection basis can be used in a network to elevate the priority of a given user temporarily. RSVP runs end to end to communicate application requirements for special handling. RSVP identifies a session between a client and a server and asks the routers handling the session to give its communications a priority in accessing **resources**. When the session is completed, the **resources** reserved for the session are freed for the use of others.

Detail Description Paragraph - DETX (275):
[0329] The present invention supports RSVP by providing: (1) compatibility with RFC 2205; (2) recognition and support of RSVP messages, including: Path messages, Reservation (Resv), Path teardown messages, Resv teardown messages, Path error messages, Resv error messages, and Confirmation messages; (3) recognition and support of RSVP objects, including: Null, Session, RSVP_Hop, Time_Values, Style, Flowspec, Sender_Template, Sender_Tspec, Adspec, Error_Spec, Policy_Data, Integrity, and Scope, Resv_Confirm; (4) configurable translation of RSVP Flowspecs for QoS **resource** allocation in wireless base station 302.

Detail Description Paragraph - DETX (276):
[0330] The present invention provides support of DiffServ and RSVP/int-serv by providing: (1) support of RFC 2474 and 2475; (2) DiffServ in the core of Internet; (3) RSVP/int-serv for hosts and edge networks; (4) admission control capability for DiffServ compatibility; (5) differentiated services (DSs) (a field marking supported for use by DiffServ, and translation into a wireless base station 302 **resource** allocation); and (6) support for binding of multiple end-to-end sessions to one tunnel session.

Detail Description Paragraph - DETX (279):
[0333] RTP and other Internet real-time protocols, such as the Internet stream protocol version 2 (ST2), focus on the efficiency of data transport. RTP and other Internet real-time protocols like RTCP are designed for communications sessions that are persistent and that exchange large amounts of data. RTP does not handle **resource** reservation or QoS control. Instead, RTP relies on **resource** reservation protocols such as RSVP, communicating dynamically to allocate appropriate bandwidth.

Detail Description Paragraph - DETX (285):
[0339] Real-time transport protocol (RTP) is currently an IETF draft, designed for end-to-end, real-time delivery of data such as video and voice. RTP works over the user datagram protocol (UDP), providing no guarantee of in-time delivery, quality of service (QoS), delivery, or order of delivery. RTP works in conjunction with a mixer and translator and supports encryption

and security. The real-time control protocol (RTCP) is a part of the RTP definition that analyzes network conditions. RTCP provides mandatory **monitoring** of services and collects information on participants. RTP communicates with RSVP dynamically to allocate appropriate bandwidth.

Detail Description Paragraph - DETX (286):
[0340] Internet packets typically move on a first-come, first-serve basis. When the network becomes congested, **Resource** Reservation Protocol (RSVP) can enable certain types of traffic, such as video conferences, to be delivered before less time-sensitive traffic such as E-mail for potentially a premium price. RSVP could change the Internet's pricing structure by offering different QoS at different prices. Using **SLAs,** different QoS levels can be provided to users at CPE location stations depending on **SLA** subscription level.

Detail Description Paragraph - DETX (287):
[0341] The RSVP protocol can be used by a host, on behalf of an application, to request a specific QoS from the network for particular data streams or flows. Routers can use the RSVP protocol to deliver QoS control requests to all necessary network nodes to establish and maintain the state necessary to provide the requested service. RSVP requests can generally, although not necessarily, result in **resources** being reserved in each node along the data path.

Detail Description Paragraph - DETX (288):
[0342] RSVP is not itself a routing protocol. RSVP is designed to operate with current and future uni-cast and multi-cast routing protocols. An RSVP process consults the local routing **database** to obtain routes. In the multi-cast case for example, the host sends IGMP messages to join a multi-cast group and then sends RSVP messages to reserve **resources** along the delivery paths of that group. Routing protocols determine where packets are forwarded. RSVP is concerned with only the QoS of those packets as they are forwarded in accordance with that routing. The present invention delivers QoS-aware wireless PtMP access to users over a shared wireless bandwidth, and can take into account priority information provided within packet headers of packets in IP flows received for transmission over the wireless base station's bandwidth.

Detail Description Paragraph - DETX (296):
[0350] The "tunneling" in PPTP refers to encapsulating a message so that the message can be encrypted and then transmitted over the Internet. PPTP, by creating a tunnel between the server and the client, can tie up processing **resources**.

Detail Description Paragraph - DETX (331):
[0385] Downlink flow scheduler places the data packets of an IP data flow into a class queue based on class queue priorities, and using a set of rules, schedules the data packets for transmission over a wireless medium to a subscriber CPE station 294 at subscriber CPE location 306 with an advanced reservation algorithm. The rules are determined by inputs to the downlink flow

scheduler based on, e.g., a hierarchical class-based prioritization, a virtual private network (VPN) directory enabled data priority (such as, for example, directory enabled networking (DEN)), and a **service level agreement** priority. The advanced reservation algorithm for use in scheduling, e.g., isochronous traffic, is described with respect to FIG. 14 below.

Detail Description Paragraph - DETX (337):

[0391] Block diagram 800 lists an exemplary set of priorities 812 used by downlink flow scheduler 604 to place received data packets into priority class queues. Listed are the following set of example priorities: latency-sensitive UDP prority 812a, high priority 812b, intermediate priority 812c, initial hypertext transfer protocol (HTTP) screens priority 812d, latency-neutral priority 812e, file transfer protocol (FTP), simple mail transfer protocol (SMTP) and other e-mail traffic priority 812f and low priority 812g. Persons skilled in the art will recognize that many different priority classes are possible, depending upon the QoS requirements of the end-users. Latency-sensitive UDP priority data can refer to data that has the highest priority because it is sensitive to jitter (i.e., time synchronization is important) and latency (i.e., the amount of time passage between IP data flows in reverse directions). High priority 812b can refer to, e.g., premium VPN service, and a high priority **SLA** service. Intermediate priority 812c can refer to, e.g., a value VPN service level and an intermediate level **SLA** service. HTTP screens priority 812d can refer to the download of HTTP data, for example, an initial HTTP screen, which is important for making an Internet user feel as if he has a great deal of bandwidth available for his Internet session. Latency-neutral priority 812e can refer to data that is neutral to latency, such as, e.g., e-mail traffic. FTP, SMTP priority 812f data includes data that is insensitive to latency and jitter, but requires a large amount of bandwidth to be downloaded accurately because of the size of a transmission. Finally, low priority data 812g can refer to data that can be transmitted over a long period of time, as when one network device transmits its status information to another network device on a 24 hour basis.

Detail Description Paragraph - DETX (345):

[0399] In this embodiment, the scheduling function is performed at uplink flow scheduler 634 at wireless base station 302 based on classification information provided to the wireless base station 302 through an uplink IP flow reservation request from the CPE station. By placing all scheduling function at the wireless base station 320, overall system quality of service can be **optimized** by centralizing the control of scheduling.

Detail Description Paragraph - DETX (349):

[0403] FIG. 9 illustrates how PRIMMA MAC IP flow scheduler 604 can also take into account a **Service Level Agreement** in prioritizing frame slot scheduling and **resource** allocation. FIG. 9 depicts **SLA**-mediated IP flow management diagram 900 including prioritization of uplink traffic being transmitted to wireless base station 302 from CPE subscriber locations 306a, 306b, 306c and 306d. For example, suppose subscribers of telecommunications services have subscribed to one of four **SLA** levels, P1 902a, P2 904a, P3 906a and P4 908a. In the illustrated example, suppose IP flows 902b are being sent to a

subscriber at CPE location 306a and have an **SLA** priority level of P1 902a. Similarly, IP flows 904b, 906b and 908b are being sent to subscribers at CPE locations 306b, 306c and 306d and have **SLA** priority levels of P2 904a, 906a and 908a, respectively. PRIMMA MAC scheduler 604, 634 of wireless base station 302 can take into account **SLA**-based priorities in allocating available bandwidth to the subscriber CPE IP flows 902b, 904b, 906b and 908b. In the example illustration, IP flow 902b can be allocated frame slot 902c based on **SLA** priority 902a. Frame slots 904c, 906c and 908c can be similarly scheduled taking into account **SLA** priorities. Uplinked IP flow traffic can then be transmitted on to data network 142.

Detail Description Paragraph - DETX (350):

[0404] **SLA**-based prioritization can provide a valuable means for a telecommunications provider to provide differentiated services to a variety of customers. For example, it is possible that low priority traffic from a subscriber who has purchased a premium **SLA** service agreement, can be scheduled at a higher priority than high priority traffic from a subscriber which has only signed up for a value level or low cost **SLA** service priority.

Detail Description Paragraph - DETX (352):

[0406] FIG. 7 illustrates packet header field information 700 which can be used to identify IP flows and the QoS requirements of the IP flows. Specifically, IP header fields 702 can include, e.g., source and destination IP addresses, helpful in providing application aware preferential **resource** allocation; IP type of service (TOS), a useful field for assisting PRIMMA MAC in classifying a packet or IP flow; IP time to live (TTL), a useful field for anticipating application packet discards; and protocol fields which can be used in identifying IP flows.

Detail Description Paragraph - DETX (363):

[0417] In the present embodiment the sum of all TDMA slots 1222 within a frame of frame size 1228 is fixed. However, as noted, using the **resource** allocation methodologies of the present invention it is possible to dynamically allocate a subset of the entire number of TDMA slots 1222 to an uplink direction, where all the uplink TDMA slots are known collectively as an uplink subframe or an upstream transmission subframe 1204, and to dynamically allocate a subset of the entire number of TDMA slots 1222 to a downlink direction, where all the downlink TDMA slots are known collectively as a downlink subframe or an downlink transmission subframe 1202. Using the **resource** allocation method of the present invention, it is possible to allocate all TDMA slots 1222 to a given upstream or downstream direction. It is further possible to allocate all data slots 1224 to a single CPE station. The wireless base station 302 has a state machine, and knows the state of each CPE station 294 having a connection therewith (i.e., having an IP flow recognized by the wireless base station 294).

Detail Description Paragraph - DETX (396):

[0450] Referring to FIG. 12M, system state subslot 1248a comprises system mode 1250a (the mode of the CPE station, e.g., command mode, operations mode,

or initialization mode of the system), system status 1250b (the status of the CPE station), system **resources** 1250a (the mode of the CPE station), system power 1250b (the mode of the CPE station), system temperature 1250a (the temperature of the CPE station). The CPE stations 294 are required to take turns using ODB 1242 to transmit their information.

Detail Description Paragraph - DETX (401):

[0455] Based on inputs from a hierarchical class-based priority processor, a virtual private network (VPN) directory enabled (DEN) data table and a **service level agreement (SLA)** priority data table (described below with respect to FIGS. 15A and 15B), the class 1, class 2, and class 3 packet flow queues are respectively assigned to class 1 downstream queue 1302, class 2 downstream queue 1304, and class 3 downstream queue 1306. Flow scheduler 604, 634 schedules these downlink data packets onto the downlink transmission subframe 1202.

Detail Description Paragraph - DETX (420):

[0474] Downlink flow scheduler 604 places the data packets of an IP data flow into a class queue, and based on a set of rules, schedules the data packets for transmission over the wireless medium to a subscriber CPE station using, e.g., an advanced reservation algorithm. The rules can be determined by inputs to the downlink flow scheduler from a hierarchical class-based priority processor module 1574, a virtual private network (VPN) directory enabled (DEN) data table 1572, and a **service level agreement (SLA)** priority data table 1570. The advanced reservation algorithm is described further above with respect to FIG. 14.

Detail Description Paragraph - DETX (441):

[0495] The exemplary logical flow diagram 1560 for the downlink flow scheduler 604 of FIG. 15B comprises IP flow QoS class queuing processor module 1562, MAC downlink subframe scheduler module 1566, hierarchical class-based priority processor module 1574, VPN DEN data table module 1572, **SLA** priority data table 1570, CPE IP flow queue depth status processor 1582 and link layer acknowledgment processor module 1578.

Detail Description Paragraph - DETX (447):

[0501] Module 1562 can receive inputs from hierarchical class-based priority processor module 1574, VPN DEN data table 1572 and **service level agreement (SLA)** priority data table 1570. The queuing function of module 1562 can be based on these inputs.

Detail Description Paragraph - DETX (448):

[0502] **SLA** priority data table 1570 can use predetermined **service level agreements** for particular customers to affect the queuing function. A customer can be provided a higher quality of telecommunications service by, for example, paying additional money to receive such premium service. An algorithm running on module 1562 can increase the queuing priority for messages transmitted to such customers.

Detail Description Paragraph - DETX (449):

[0503] Virtual private network (VPN) directory enabled networking (DEN) data table 1572 can provide prioritization for a predetermined quality of service for a VPN for a company that pays for the VPN function. A VPN is understood by those skilled in the relevant art to be a private network, including a guaranteed allocation of bandwidth on the network, provided by the telecommunications service provider. VPN DEN data table 1572 permits module 1562 to provide higher quality of service for customer-purchased VPNs. As with **SLA** priority data table 1570, the queuing priority can be increased for such VPNs. For example, a platinum level VPN's lowest priority IP flow classes could also be given a higher priority than a high priority brass level VPN.

Detail Description Paragraph - DETX (450):

[0504] Both **SLA** priority data table 1570 and VPN DEN data table 1572 receive input from operations, administration, maintenance and provisioning (OAM&P) module 1108. This is a module that is kept off-line, and includes storage and revision of administrative information regarding new customers, or updates of information pertaining to existing customers. For example, the **SLA** priority of the customers and VPN information is updated from OAM&P module 1108.

Detail Description Paragraph - DETX (468):

[0522] Each time a subscriber CPE station 294d attempts to communicate in the uplink direction with wireless base station 320, it requests a reservation by inserting an RRB in the uplink subframe. Uplink frame scheduler 634 then schedules the reservation request in a future uplink subframe and notifies the CPE station 294d of the reservation. In a downlink signal, uplink flow scheduler 634 located preferably at wireless base station 320, transmits a reservation slot in a particular future frame for the requesting subscriber CPE station 294d to transmit its uplink data. Uplink flow scheduler 634 assigns the reservation based on the same parameters as the downlink flow scheduler 604 uses in the downlink. In other words, uplink flow scheduler 634 determines the reservation slots based on the queue class priority and based on a set of rules, schedules the reservations for uplink transmissions from subscriber CPE station 294d using, e.g., an advanced reservation algorithm. The rules are determined by inputs to the uplink flow scheduler 634 from a hierarchical class-based priority processor module 1674, a virtual private network (VPN) directory enabled (DEN) data table 1672, and a **service level agreement (SLA)** priority data table 1670. The advanced reservation algorithm is described with respect to FIG. 14.

Detail Description Paragraph - DETX (490):

[0544] The exemplary logical flow diagram for the uplink flow scheduler 634 of FIG. 16B comprises IP flow QoS class queuing processor module 1662, MAC uplink subframe scheduler module 1666, hierarchical class-based priority processor module 1674, VPN DEN data table module 1672, **SLA** priority data table 1670, CPE IP flow queue depth status processor 1682 and link layer acknowledgment processor module 1678.

Detail Description Paragraph - DETX (498):
[0552] The future slot(s) in the future frame(s) are assigned, e.g., based on inputs from hierarchical class-based priority processor module 1674, VPN DEN data table 1672 and **service level agreement (SLA)** priority data table 1670. These components function in a similar manner to hierarchical class-based priority processor module 1574, VPN DEN data table 1572 and **service level agreement (SLA)** priority data table 1570, described with respect to the downlink flow scheduler 604.

Detail Description Paragraph - DETX (500):
[0554] Module 1662 receives inputs from hierarchical class-based priority processor module 1674, VPN DEN data table 1672 and **service level agreement (SLA)** priority data table 1670. The queuing function of module 1662 is based on these inputs. These components function analogously to their counterparts in the downlink flow scheduling method. **SLA** priority data table 1670 and VPN DEN data table 1672 receive input from operations, administration, maintenance and provisioning (OAM&P) module 1108. OAM&P module 1108 provides updates to priorities when, e.g., a subscriber modifies its **service level agreement** or a VPN subscription is changed.

Detail Description Paragraph - DETX (510):
[0564] In the presence of the high bit-error rates characteristic of wireless environments, TCP reacts to packet losses as it would in the wired environment, i.e. it drops its transmission window size before retransmitting packets, initiates congestion control or avoidance mechanisms (e.g., slow start) and resets its retransmission timer. These **measures** result in an unnecessary reduction in the link's bandwidth utilization, thereby causing a significant degradation in performance in the form of poor throughput and very high interactive delays.

Detail Description Paragraph - DETX (515):
[0569] TCP adjunct agent 510e makes sure transport is reliable by modifying operation of the TCP sliding window algorithm at the transmitting TCP in a manner that **optimizes** the window for the wireless medium. TCP adjunct agent 510e advantageously is transparent to industry standard protocols as agent 510e does not require modification of the standard TCP/UDP layer of client subscriber workstation 120d or host workstation 136a.

Detail Description Paragraph - DETX (520):
[0574] TCP/UDP layers 510a and 510f act to provide such transport functions as, e.g., segmentation, managing a transmission window, resequencing, and requesting retransmission of lost packet flows. Normally TCP layers 510a and 510f would send a window of packets and then await acknowledgment or requests for retransmission. A TCP sliding window algorithm is normally used to vary the transmission flow to provide **optimized** transport and to back off when congestion is detected by receipt of requests for retransmission. Unfortunately in the wireless environment, due to high bit error rates, not all packets may reach the destination address, not because of congestion, but

rather because of high bit error rates, so as to prompt a retransmission request from the destination IP host to the source. Rather than slow transport, TCP adjunct agent 510e modifies operation of the TCP sliding window algorithm to **optimize** operation over wireless. PRIMMA MAC layer 504d interacts with TCP adjunct agent 510e permitting the agent to intercept, e.g., retransmission requests, from TCP layer 510a of subscriber workstation 120d intended for host 136a, and allowing the wireless base station to retransmit the desired packets or flows to subscriber workstation 120d rather than forwarding on the retransmission request to host 136a, since the packets could still be stored in the queue of PRIMMA 504d and would not be discarded until an acknowledgment of receipt is received from the subscriber CPE. Since retransmission can be performed according to the present invention at the PRIMMA MAC data link layer, i.e. layer 2, retransmission can occur from the base station to the CPE subscriber, rather than requiring a retransmission from all the way over at the transmitting source TCP which would cause TCP to backoff its sliding window algorithm. Thus, by having wireless base station 302 retransmit until receipt is acknowledged over the wireless link, the inherently high bit error rate can be overcome, while maintaining an optimal TCP window.

Detail Description Paragraph - DETX (546):
[0600] WAN interface 320 is bidirectionally linked to a bidirectional data frame FIFO 1002 which is bidirectionally coupled to both segmentation and resequencing (SAR) 1004 and QoS/**SLA** rules engine and processor 1008.

Detail Description Paragraph - DETX (547):
[0601] QoS/**SLA** rules engine and processor 1008 is also bidirectionally coupled to IP flow buffers 1014 and flash random access memory (RAM) 1010.

Detail Description Paragraph - DETX (548):
[0602] SAR 1004 is bidirectionally coupled to IP flow buffers 1014, flash RAM 1010, QoS/**SLA** rules engine and processor 1008 and PRIMA MAC scheduler ASIC 1012.

Detail Description Paragraph - DETX (551):
[0605] FIG. 11 is an exemplary software organization for a packet-centric wireless point to multi-point telecommunications system. The software organization of FIG. 11 includes wireless transceiver and RF application specific integrated circuit (ASIC) module 290, IP flow control component 1102, WAN interface management component 1104, QoS and **SLA** administration component 1106, system and OAM&P component 1108, customer billing and logging component 1110, directory enabled networking (DEN) component 1112, and wireless base station 320.

Detail Description Paragraph - DETX (555):
[0609] QoS and **SLA** administration component 1106 includes includes QoS performance **monitoring** and control module 1106a, **service level agreements** module 1106b, policy manager module 1106c and encryption administration module

1106d.

Detail Description Paragraph - DETX (556):
[0610] The QoS and **SLA** administration component 1106 provides the static data needed by the system in order to properly group particular IP-flows into QoS classes. Typically, during the provisioning phase of installing the system, the service provider will (remotely) download pertinent information about the subscriber CPE station 294, including the subscriber CPE stations's **SLA,** any policy-based information (such as hours of operation or peak data transmission rate allowance.). Encryption keys or "strengths" can also be downloaded, which may be subscriber CPE station or service provider specific.

Detail Description Paragraph - DETX (558):
[0612] The OAM&P component 1108 allows remote service personnel and equipment to **monitor,** control, service, modify and repair the system. System performance levels can be automatically **monitored,** and system traps and traces can be set. Subscriber complaints can be addressed with the use of remote test and debug services controlled by OAM&P component 1108. System capacity limits can be **monitored,** and proactive provisioning of additional WAN connectivity can occur, as the result of automatic trend analysis functions in OAM&P component 1108.

Detail Description Paragraph - DETX (559):
[0613] Customer billing and logging module 1110 includes account logging and **database** management module 1110a, transaction query and processing control module 1110b, billing and account control module 111c, and user authentication module 1110d.

Detail Description Paragraph - DETX (560):
[0614] The customer billing and logging component 1110 allows the service provider to receive account, billing and transaction information pertaining to subscribers in the system. For service providers who bill on the basis of usage, cumulative system **resource** utilization data can be gathered. For specific types of activities (eg. video conferencing, multi-casting, etc.) there may be special billing data that is collected and transmitted to the service provider. This component also controls the availability of the system to subscribers through the operation of the subscriber authentication function. Once a subscriber is authorized to use the system, a new subscriber authentication entry is made (remotely) by the service provider. Likewise, a subscriber can be denied further access to the system for delinquent payment for services, or for other reasons. The service provider can also remotely query the system for specific account-related transactions.

Detail Description Paragraph - DETX (562):
[0616] The DEN component 1112 allows the service provider the means to input into the system relevant information regarding the operation of DEN-based VPN's of subscribers. Subscriber VPNs need to be "initialized" and "provisioned" so that the system properly allocates system **resources** to subscribers with these

VPNs, and provides for the recognition and operation of these VPNs. Data from DEN component 1112 are utilized by the system to apply the appropriate priorities to IP-flows of the subject subscribers.

Detail Description Table CWU - DETL (1):
1TABLE 1 Term Definition access tandem (AT) An AT is a class 3/4 switch used to switch calls between EOs in a LATA. An AT provides subscribers access to the ICXs, to provide long distance calling services. An access tandem is a network node. Other network nodes can include, for example, a CLEC, or other enhanced services provider (ESP), an international gateway or global point-of-presence (GPOP), or an intelligent peripheral (IP). bearer (B) channels Bearer (B) channels are digital channels used to carry both digital voice and digital data information. An ISDN bearer channel is 64,000 bits per second, which carry PCM-digitized voice or data. called party The called party is the caller receiving a call sent over a network at the destination or termination end. calling party The calling party is the caller placing a call over any kind of network from the origination end. central office (CO) A CO is a facility that houses an EO homed. EOs are often called COs. class 1 switch A class 1 switching office, the Regional Center (RC), is the highest level of local and long distance switching, or "office of last resort" to complete a call. class 3 switch A class 3 switching office was a Primary Center (PC); an access tandem (AT) has class 3 functionality. class 4 switch A class 4 switching office was a Toll Center (TC) if operators were present or else a Toll Point (TP); an access tandem (AT) has class 4 functionality. class 5 switch A class 5 switching office is an end office (EO) or the lowest level of local and long distance switching, a local central office. The switch closest to the end subscriber. competitive LEC CLECs are telecommunications services providers of local services (CLEC) that can compete with ILECs. Interprise and Century 21 are examples. A CLEC may or may not handle IXC services as well. competitive access Teligent and Winstar are examples. providers (CAPS) customer premises CPE refers to devices residing on the premises of a customer and used equipment (CPE) to connect to a telephone network, including ordinary telephones, key telephone systems, PBXs, video conferencing devices and modems. digitized data (or Digitized data refers to analog data that has been sampled into a digital data) binary representation (i.e., comprising sequences of 0's and 1's). Digitized data is less susceptible to noise and attenuation distortions because it is more easily regenerated to reconstruct the original signal. egress end office The egress EO is the node or destination EO with a direct connection to the called party, the termination point. The called party is "homed" to the egress EO. egress Egress refers to the connection from a called party or termination at the destination end of a network, to the serving wire center (SWC). end office (EO) An EO is a class 5 switch used to switch local calls within a LATA. Subscribers of the LEC are connected ("homed") to EOs, meaning that EOs are the last switches to which the subscribers are connected. Enhanced Service A network services provider. Provider (ESP) equal access 1 + dialing as used in US domestic calling for access to any long distance carrier as required under the terms of the modified final judgment (MFJ) requiring divestiture of the Regional Bell Operating Companies (RBOCs) from their parent company, AT&T. global point of A GPOP refers to the location where international presence (GPOP) telecommunications facilities and domestic facilities interface, an international gateway POP. incumbent LEC ILECs are traditional LECs in the US, which are the Regional Bell (ILEC)

Operating Companies (RBOCs). Bell South and US West are examples. ILEC can also stand for an independent LEC such as a GTE. ingress end office The ingress EO is the node or serving wire center (SVC) with a direct connection to the calling party, the origination point. The calling party is "homed" to the ingress EO. ingress Ingress refers to the connection from a calling party or origination. integrated service An ISDN Basic Rate Interface (BRI) line provides 2 bearer B digital network channels and 1 data D line (known as "2B + D" over one or two pairs) (ISDN) basic rate to a subscriber. interface (BRI) line integrated services ISDN is a network that provides a standard for communications digital network (voice, data and signaling), end-to-end digital transmission circuits, (ISDN) out-of-band signaling, and a features significant amount of bandwidth. inter machine trunk An inter-machine trunk (IMT) is a circuit between two commonly- (IMT) connected switches. inter-exchange IXCs are US domestic long distance telecommunications services carrier (IXC) providers. AT&T, MCI, Sprint, are examples. internet protocol (IP) IP is part of the TCP/IP protocols. It is used to recognize incoming messages, route outgoing messages, and keep track of Internet node addresses (using a number to specify a TCP/IP host on the Internet). IP corresponds to the network layer of OSI. Internet service An ISP is a company that provides Internet access to subscribers. provider (ISP) ISDN primary rate An ISDN Primary Rate Interface (PRI) line provides the ISDN interface (PRI) equivalent of a T1 circuit. The PRI delivered to a customer's premises can provide 23B + D (in North America) or 30B + D (in Europe) channels running at 1.544 megabits per second and 2.048 megabits per second, respectively. local exchange LECs are local telecommunications services providers. Bell Atlantic carrier (LEC) and US West are examples. local access and A LATA is a region in which a LEC offers services. There are over transport area 160 LATAs of these local geographical areas within the United States. LATA local area network A LAN is a communications network providing connections between (LAN) computers and peripheral devices (e.g., printers and modems) over a relatively short distance (e.g., within a building) under standardized control. modified final Modified final judgment (MFJ) was the decision requiring divestiture judgment (MFJ) of the Regional Bell Operating Companies (RBOCs) from their parent company, AT&T. network node A network node is a generic term for the **resources** in a telecommunications network, including switches, DACS, regenerators, etc. Network nodes essentially include all non-circuit (transport) devices. Other network nodes can include, for example, equipment of a CLEC, or other enhanced service provider (ESP), a point-of-presence (POP), an international gateway or global point-of- presence (GPOP). new entrant (NE) A new generation global telecommunications. next generation A new telecommunications services provider, especially IP telephony telephone (NGT) providers. Examples are Level 3 and Qwest. packetized voice or One example of packetized voice is voice over internet protocol voice over a (VOIP). Voice over packet refers to the carrying of telephony or backbone voice traffic over a data network, e.g. voice over frame, voice over ATM, voice over Internet Protocol (IP), over virtual private networks (VPNs), voice over a backbone, etc. Pipe or dedicated A pipe or dedicated communications facility connects an ISP to the communications internet. facility point of presence A POP refers to the location within a LATA where the IXC and LEC (POP) facilities interface. point-to-point A virtual private networking protocol, point-to-point tunneling tunneling protocol protocol (PPTP), can be used to create a "tunnel" between a remote (PPTP) user and a data network. A tunnel permits a network administrator to extend a virtual

private network (VPN) from a server (e.g., a Windows NT server) to a data network (e.g., the Internet). point-to-point (PPP) PPP is a protocol permitting a computer to establish a connection with protocol the Internet using a modem. PPP supports high-quality graphical front ends, like Netscape. postal telephone State regulated telephone companies, many of which are being telegraph (PTT) deregulated. NTT is an example. private branch A PBX is a private switch located on the premises of a user. The user exchange (PBX) is typically a private company which desires to provide switching locally. private line with a A private line is a direct channel specifically dedicated to a customer's dial tone use between two specificed points. A private line with a dial tone can connect a PBX or an ISP's access concentrator to an end office (e.g. a channelized T1 or PRI). A private line can also be known as a leased line. public switched The PSTN is the worldwide switched voice network. telephone network (PSTN) regional Bell RBOCs are the Bell operating companies providing LEC services operating companies after being divested from AT&T. (RBOCs) signaling system 7 SS7 is a type of common channel interoffice signaling (CCIS) used (SS7) widely throughout the world. The SS7 network provides the signaling functions of indicating the arrival of

Detail Description Table CWU - DETL (2):

calls, transmitting routing and destination signals, and **monitoring** line and circuit status.. switching hierarchy An office class is a functional ranking of a telephone central office or office switch depending on transmission requirements and hierarchical classification relationship to other switching centers. Prior to AT&T's divestiture of the RBOCs, an office classification was the number assigned to offices according to their hierarchical function in the U.S. public switched network (PSTN). The following class numbers are used: class 1 = Regional Center (RC), class 2 = Sectional Center (SC), class 3 = Primary Center (PC), class 4 = Toll Center (TC) if operators are present or else Toll Point (TP), class 5 = End Office (EO) a local central office. Any one center handles traffic from one to two or more centers lower in the hierarchy. Since divestiture and with more intelligent software in switching offices, these designations have become less firm. The class 5 switch was the closest to the end subscriber. Technology has distributed technology closer to the end user, diffusing traditional definitions of network switching hierarchies and the class of switches. telecommunications A LEC, a CLEC, an IXC, an Enhanced Service Provider (ESP), an carrier intelligent peripheral (IP), an international/global point-of-presence (GPOP), i.e., any provider of telecommunications services. transmission control TCP is an end-to-end protocol that operates at the transport and protocol (TCP) sessions layers of OSI, providing delivery of data bytes between processes running in host computers via separation and sequencing of IP packets. transmission control TCP/IP is a protocol that provides communications between protocol/internet interconnected networks. The TCP/IP protocol is widely used on the protocol (TCP/IP) Internet, which is a network comprising several large networks connected by high-speed connections. trunk A trunk connects an access tandem (AT) to an end office (EO). wide area network A WAN is a data network that extends a LAN over the circuits of a (WAN) telecommunications carrier. The carrier is typically a common carrier. A bridging switch or a router is used to connect the LAN to the WAN.

Detail Description Table CWU - DETL (5):
4TABLE 4 SS7 link terminology Definitions Access (A) links A links connect SSPs to STPs, or SCPs to STPs, providing network access and **database** access through the STPs. Bridge (B) links B links connect mated STPs to other mated STPs. Cross (C) links C links connect the STPs in a mated pair to one another. During normal conditions, only network management messages are sent over C links. Diagonal (D) links D links connect the mated STPs at a primary hierarchical level to mated STPs at a secondary hierarchical level. Extended (E) links E links connect SSPs to remote mated STPs, and are used in the event that the A links to home mated STPs are congested. Fully associated F links provide direct connections between local (F) links SSPs (bypassing STPs) in the event there is much traffic between SSPs, or if a direct connection to an STP is not available. F links are used only for call setup and call teardown.

Claims Text - CLTX (5):
4. The system of claim 1, further comprising: **resource** allocation means for allocating shared bandwidth among said subscriber CPE stations.

Claims Text - CLTX (6):
5. The system of claim 4, wherein said **resource** allocation is performed to **optimize** end-user quality of service (QoS).

Claims Text - CLTX (11):
10. The system of claim 1, further comprising: a **resource** allocator that allocates shared bandwidth among said subscriber CPE stations.

Claims Text - CLTX (12):
11. The system of claim 10, wherein said **resource** allocator **optimizes** end-user quality of service (Qos).

Claims Text - CLTX (13):
12. The system of claim 10, wherein said **resource** allocator is application aware.